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The Impact of COVID-19 on the Urology Residency Match and Geographic Proximity of Applicants

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OBJECTIVE	To determine the impacts of COVID-19 pandemic-related changes and program-specific characteristics on the geographic diversity of the 2021 and 2022 urology match classes.
METHODS	We gathered publicly available information to compare match outcomes in 2021 and 2022 to the previous 5 application cycles (2016-2020). Variables included residency program class size, program and resident AUA section, and program and resident medical school. Univariate comparisons were made with Fisher's t-tests. Odds ratios were calculated following multivariable analysis.
RESULTS	Comparing the previous 5 application cycles to the 2 pandemic years individually and together showed no significant changes in home or in-section matches. However, when comparisons were stratified by small (1-2 residents) vs large (3+ residents) programs, a significant increase in at-home and in-section matches was observed for small programs in 2021. Large programs did not experience significant changes in match patterns. Multivariate analysis showed that small programs had significantly lower odds of matching applicants from home institutions and within AUA sections. Additionally, certain AUA sections demonstrated significantly increased likelihood of accepting in-section applicants.
CONCLUSION	The changes from in-person to virtual application cycles during the pandemic particularly affected small residency programs in 2021. With easing restrictions and logistical improvements in the 2022 cycle, locoregional match rates partially shifted back to prepandemic patterns, though not completely. Although the pandemic did not affect geographic diversity in urology as much as in other surgical subspecialties, these findings and further study should be considered to optimize upcoming cycles. UROLOGY 176: 21–27, 2023. © 2023 Elsevier Inc.

The COVID-19 pandemic transformed applicant experiences and strategies surrounding the urology residency match. Importantly, the 2020-2021 application cycle saw the abrupt adoption of virtual interviews and cancellation of in-person away rotations. Subsequently in 2021-2022, interviews remained virtual but applicants were permitted one away rotation.^{1,2} While away rotation restrictions have since been lifted for the 2022-2023 cycle, the Association of American Medical Colleges and Society of Academic Urologists continue to recommend virtual interviews. These shifting policies have precipitated questions surrounding downstream implications on the satisfaction, diversity, and quality of future residents.

While subjective applicant- and faculty-reported experiences with pandemic-era changes are well-described, objective effects on urology match outcomes remain unclear. As the urology match becomes increasingly competitive, appropriate screening and evaluation tools are crucial. Strong geographic ties often serve as auxiliary measures of perceived interest.^{3–5} Moreover, geographic proximity facilitates networking to build program familiarity with prospective candidates or their faculty mentors. Previously, applicants lacking established geographic ties would utilize interviews, away rotations, and associated recommendation letters to express interest, but pandemic-related changes have complicated this strategy.⁶ Limited in-person interactions also prevented evaluation of skillset, personality, and cultural fit. Nonetheless, Patel et al found that although geography is applicants' primary consideration in away rotation selection, away rotations seemingly did not affect match outcomes, making it unclear whether these common applicant strategies were worthwhile.⁷

Contrary to expectations, Gabrielson et al found that 2021 urology applicants were not more likely to match at their home institution, and there was no change in the mean distance between residency program and the

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applicant's medical school, undergraduate institution, or home state when compared to prepandemic applicants.^{5,8} It is necessary to investigate residency program characteristics, such as size, which may affect differences in match trends between the pre- and postpandemic years. Furthermore, outcomes from the 2022 cycle have not yet been investigated, and it is unknown whether improvements to the virtual format in 2022 compared to the sudden changes in the 2021 cycle have reverted trends to prepandemic patterns. Understanding these patterns can provide points of improvement to facilitate geographic equity and diversity. We aimed to investigate the impacts of pandemic-era changes and program-specific characteristics on geographic diversity amongst the 2021 and 2022 urology match classes.

METHODS

Using publicly available information on urology residency program websites and social media platforms, data were gathered from all United States nonmilitary accredited urology residency programs for the 2016-2022 match cycles. Data collection occurred through March 2022, and subsequent changes to residency rosters were not included. Variables of interest included each program's size, location, medical school affiliation, and AUA section, along with each urology resident's medical school. AUA sections included the following categories: Mid-Atlantic, New England, New York, North Central, Northeastern, South Central, Southeastern, and Western.

Statistical analyses were performed to compare match rates for students from home institutions or within AUA sections based on match year and residency program size. For home match rate analysis, programs lacking an affiliated medical school were excluded.

The pandemic-associated (2021 and 2022) match data were separately compared with prepandemic (2016-2020) match data. These two years were also combined into one pandemic-era cohort (2021-2022) to compare overall outcomes with prepandemic applicants (2016-2020). Further analysis was performed after stratification by program size (small: ≤ 2 residents/year, large: ≥ 3 residents/year). Similar analysis was performed for single-resident and multiple-resident programs. Finally, prepandemic and pandemic-era outcomes were compared between all eight AUA sections.

Univariate comparisons were made using Fisher's exact test. Multinomial logistical regressions were performed to calculate odds ratios for matching home or in-section applicants after adjustment for program size, AUA section, and year. All statistical tests were two-tailed, and $P < .05$ was considered statistically significant. Statistical analyses were performed using GraphPad Prism 9.0.2 (San Diego, CA).

RESULTS

Information on 363/365 (99.5%) filled positions in 2022, 356/357 (99.7%) filled positions in 2021, and 1,669/1,903 (87.7%) filled positions from 2016-2020 was procured online. Summarized match statistics are outlined in [Table 1](#).⁹

In 2021, programs filled 69 of 324 (21.3%) positions with students from their home institution, which was not significantly higher than the 2016-2020 cycles, when 17.4% of positions were filled with home students ([Table 2](#), $P = .096$). Similarly, 63 of 329 (19.01%) spots were filled with home students in 2022, which was not significantly higher than 2016-2020 ($P = .47$). In 2021, 160 of 357 (44.8%) spots were filled by applicants within the AUA section, which was not significantly different from 2016-2020 ($P = .19$). Similarly, 167 of 363 (46.0%) spots in 2022 were filled with in-section students, which this was not statistically significant in comparison to 2016-2020 ($P = .10$).

When programs were stratified by size, with small programs classified as those having 1-2 residents per class, pandemic-era effects became clear and concentrated upon smaller programs in 2021, but these effects were lessened in 2022. For small programs, the 2016-2020 cycles saw 16.2% at-home matches, vs 28.1% in 2021 ($P = .011$) and 19.5% in 2022 ($P = .44$). A similar pattern was observed for AUA section, as small programs saw 41.7% of 2016-2020 spots filled by in-section applicants, while the 2021 cycle saw 57.1% matches occurring in-section ($P = .0034$) and the 2022 cycle saw only 50.5% in-section matches ($P = .11$). Large programs did not experience significant changes in at-home or in-section matches during the pandemic.

When data from the 2021 and 2022 application cycles were combined into a pandemic-era cohort and compared to prepandemic cycles, a pandemic-associated effect could not be concluded, as home (17.4% vs 20.2%, $P = .12$) and within AUA section (41.2% vs 45.5%, $P = .052$) match rates were not significantly higher in 2021-2022 ([Table 3](#)). For small programs, there was a significant increase in 2021-2022 at-home matches vs 2016-2020 (16.2% vs 23.9%, $P = .030$). This trend was not observed for large programs (17.9% vs 18.9%, $P = .67$). Similarly, the proportion of in-section matches for small programs was significantly higher for pandemic vs prepandemic cycles (53.9% vs 41.7%, $P = .0024$) ([Supplementary Figure 1](#), [Table 3](#)). Comparison between the pandemic years individually, 2021 vs 2022, did not reveal any differences ([Table 4](#)), indicating that although 2022 numerically appeared to move towards prepandemic patterns, there was no significant return to normalcy.

Subsequent analysis limited to programs with 1 resident per class demonstrated that pandemic-era effects were actually eliminated. Single-resident programs saw 13 of 58 (22.4%) positions filled with at-home applicants from 2016-2020, while the 2021 cycle saw 2 out of 7 (28.6%) such matches ($P = .66$) and the 2022 cycle saw 0 of 5 (0.0%) ($P = .057$). A similar pattern was observed for AUA section, as for single-resident programs, in comparison to the 2016-2020 cycles, which saw 40.0% of spots being filled by in-section applicants, the 2021 cycle saw 66.7% matches

Table 1. Comparison of residency positions and match rates from the 2016-2022 cycles based on American Urological Association published statistics

	2016-2020 (Mean \pm SD)	2021	2022
Positions Offered, n	321 \pm 21.3	357	365
Positions Unfilled, n	4 \pm 4.2	0	0
Applicant Lists Submitted, n	417 \pm 17.6	481	556
Unmatched, n	100 \pm 25.7	124	191
Overall match rate, %	76% \pm 5.7%	74%	66%
Females matched, %	76% \pm 6.8%	85%	72%

Table 2. Comparison of prepandemic (2016-2020) match classes to the classes of 2021 and 2022 by size of program: small (≤ 2 residents) and large (≥ 3 residents)

		2016-2020	2021	P-value (vs 2016-2020)	2022	P-value (vs 2016-2020)
Matched at home program	All residency programs	268/1542 (17.4%)	69/324 (21.3%)	.096	63/329 (19.1%)	.47
	LARGE programs	194/1086 (17.9%)	44/235 (18.7%)	.78	46/242 (19.0%)	.71
	SMALL programs	74/456 (16.2%)	25/89 (28.1%)	.011*	17/87 (19.5%)	.44
Matched in AUA section	All residency programs	687/1669 (41.2%)	160/356 (44.9%)	.19	167/363 (46.0%)	.10
	LARGE programs	455/1113 (40.9%)	96/244 (39.3%)	.67	112/254 (44.1%)	.36
	SMALL programs	232/556 (41.7%)	64/112 (57.1%)	.0034*	55/109 (50.5%)	.11

Table 3. Comparison of prepandemic (2016-2020) resident match classes to pandemic classes (2021-2022)

		Prepandemic	Pandemic	P-value
Matched at home program	All residency programs	268/1542 (17.4%)	132/653 (20.2%)	.12
	LARGE programs	194/1086 (17.9%)	90/477 (18.9%)	.67
	SMALL programs	74/456 (16.2%)	42/176 (23.9%)	.030*
Matched in AUA section	All residency programs	687/1669 (41.2%)	327/719 (45.5%)	.052
	LARGE programs	455/1113 (40.9%)	208/498 (41.8%)	.74
	SMALL programs	232/556 (41.7%)	119/221 (53.9%)	.0024*

Table 4. Comparison of match class of 2021 to the class of 2022

		2021	2022	P-value
Matched at home program	All residency programs	69/324 (21.3%)	63/329 (19.2%)	.50
	LARGE programs	44/235 (18.7%)	46/242 (19.0%)	>.99
	SMALL programs	25/89 (28.1%)	17/87 (19.5%)	.22
Matched in AUA section	All residency programs	160/356 (44.9%)	167/363 (46.0%)	.82
	LARGE programs	96/244 (39.3%)	112/254 (44.1%)	.32
	SMALL programs	64/112 (57.1%)	55/109 (50.5%)	.35

occurring in-section ($P = .19$) while the 2022 cycle saw 55.6% of matches occurring in-section ($P = .10$). Of note, single-resident programs were significantly less likely to have an associated medical school (69 of 113 (61.1%) vs 735 of 819 (89.7%); $P < .001$), and such programs were excluded from analysis.

When studying trends within AUA sections, the Southeastern section showed a relatively significant increase in matching home (30.2% vs 15.9%, $P = .012$) and in-section (62.0% vs 45.0%, $P = .012$) applicants in 2021 vs other AUA sections (Supplementary Table 1). No sections showed a particular change in match trends during the pandemic (Supplementary Table 2).

Multivariable analysis was subsequently performed (Supplementary Table 3). Overall, small residencies had significantly lower odds than large residencies of matching home (OR = 0.42, 95% CI 0.31-0.57) and in-section (OR = 0.39, 95% CI 0.28-0.54) applicants during the pandemic. All sections except New England and Western had increased odds of accepting applicants from within their own AUA section, though this did not remain

true for home matches. 2019 and 2020 saw decreased odds of matching applicants from home when compared to 2016 as reference, but 2021 and 2022 did not follow this trend, indicating that the pandemic reversed an ongoing pattern of increasing geographic diversity.

DISCUSSION

The urology match is highly competitive, and the number of applications has continually grown with the 2022 match rate of 65.6% being the lowest in our seven-year study period. As applicants increasingly outnumber positions, applicants face growing financial burden from an increased number of applications, and programs face pressure to implement arbitrary screening measures, caps on interviews, and secondary applications.¹⁰ Program directors have stated that rankings are primarily made using

letters of recommendation, board scores, interview evaluations of character, and away rotations, all of which were impacted by the pandemic.^{6,9} Students and faculty reported that the most drastic pandemic changes involved interviews and away rotations. Although subjective experiences with these changes are well-understood, it remains unclear how this translated into actual outcomes. Better understanding of match outcomes following the COVID-19 pandemic can inform future applicant and program strategies and match policies.

Our findings add an additional year of study to corroborate early findings from Gabrielson et al, who found that there was no home or in-section geographic clustering in the first year of the pandemic.³ Our analysis indicates that large residency programs were already consistently matching applicants at home and in section from 2016-2020, and hence, the pandemic had limited effects on their match patterns. Conversely, small programs became significantly more likely to prefer geographically proximal applicants during the pandemic. For large programs particularly, the lack of away rotations, in-person interviews, professional relationships, home institution familiarity, and intra-section networking may have carried a lesser impact than hypothesized. The seemingly contradictory finding that single-resident programs did not experience this trend can likely be explained by the small sample size, as very few single-resident programs exist, and even fewer have a home medical school.

This differs from findings reported by other surgical subspecialties including otolaryngology, dermatology, and integrated plastic surgery, each of which saw an increase in shorter-distance matches whether at-home, in-state, and or in-section.^{10–12} Our negative findings indicate that academic urology may have successfully mitigated potential downsides of pandemic-associated changes, though smaller programs still faced challenges.

Our results suggest that small residencies likely experienced greater difficulty locating ideal candidates during the pandemic given virtual interviews and no away rotations. This trend may have been diluted in larger programs which can better afford to take some students of less familiarity. Larger programs may also be distanced from pandemic-related challenges because their larger faculty size inherently has a wider reach and professional network. Patel et al. similarly reported equivalent at-home matches but a significantly higher likelihood of matching within AUA section. This difference in findings could be explained by their analysis of the prepandemic years individually, which actually showed a slow increase in number of in-section matches year to year, although our analysis combined this into a prepandemic average.

Our study shows that other program-specific characteristics, outside the COVID-19 pandemic, affect the geographic distribution of matched applicants. Our multivariate logistic regression demonstrated that along with residency size, certain AUA sections had increased success in attaining geographic diversity. First, the Western and New England sections were less likely to accept

students from within their section. Odds of matching in-section applicants ranged from 3.12 (95% CI 1.37-7.15) in the New York section to 4.67 (95% CI 2.08-10.57) in the South Central section. This may be affected by the strength of inter-faculty relationships or trainee programming within certain AUA sections, in addition to the anecdotal concentration of highly sought-after programs in the New England (Ivy League) and Western (California) sections.

There are a variety of explanations for small programs' experiences during the pandemic. Some students who did not originally prefer their home or regional institutions may have felt an inability to learn about distant programs in the virtual format. Operative experience, interactions with current residents, and collegial relationships are the most important priorities for applicants, but virtual interviews made it difficult to evaluate cultural fit without facility tours and more natural interactions with current staff.¹³ Similarly, programs may have ranked local applicants who were a less ideal fit because of familiarity bias or greater availability of word-of-mouth information from colleagues. As it became difficult to evaluate cultural fit and personality for geographically distant candidates, programs may have ultimately preferred "known quantity" applicants. Finally, these obstacles preclude programs from designing an incoming class of diverse educational backgrounds and life experiences.

Our study shows that pandemic effects were more significant in 2021 than 2022. After learning from the abrupt changes made in 2021, programs likely improved their virtual offerings for the 2022 cycle. Some restrictions were lifted, such as the allowance of one away rotation in 2022.¹³ Additionally, the introduction of preference signaling in the 2022 cycle may have affected the geographic spread of applicants although the exact effects would require further study. Importantly, however, the 2022 cycle did not fully return to prepandemic normalcy, and accordingly, its locoregional match rates were not significantly lower than 2021, though they also were not higher than 2016-2020 (Supplementary Figure 2).

Programs must continue to build on lessons from the pandemic with interviews remaining virtual but away rotation limitations lifted. Virtual experiences are shown to improve with smaller group sessions, social events, and informal platforms such as online games, along with increased social media use for information-sharing and applicant education.^{14–16} Alternative programs to build relationships between faculty or residents and applicants, including webinars, meet-and-greets, and virtual sub-internships, are necessary to fill the void left by limitations in away rotations. The SAU has also developed guidelines on virtual sub-internship offerings, detailing a four-week curriculum which was implemented by at least 19 programs.¹⁷

There were unforeseen benefits in the postpandemic interview format, including cost savings and convenience, suggesting that certain pandemic-associated changes should continue. Averch et al estimated a total

spending of \$3,122,000 by the 446 applicants in the 2014 match, with each applicant attending a mean of 14 interviews, each costing an average of \$500.¹⁸ During the pandemic, a 2021 study found that applicants saved approximately \$173 per interview given reduced transportation costs, with national savings exceeding \$1 million. This difference can support efforts for equity in urology.¹⁹ Importantly, 20% of prepandemic urology applicants limited interviews for financial concerns, and it can be inferred that these limitations were concentrated in applicants from underserved communities.¹⁹ Virtual interviews even benefit the environment, as urology alone saved 3,011 tons of CO₂.¹⁴ Separate studies have found that approximately three-quarters of applicants felt that virtual interviews were well-run and supported continued use with some modifications to allow for interactivity.^{14,16,20}

Although this is the first study to analyze both postpandemic match cycles, there are limitations. We were unable to control for applicant factors such as hometown, undergraduate institution, gender, away rotations, or academic accomplishments in the multivariate analysis. Additionally, our methodology described the characteristics of programs, not applicants. Students often evaluate their probability of matching based on variables related to their own application. Nonetheless, understanding program-specific characteristics is still important as program leadership plans for upcoming cycles and evaluate future changes to the match process.

CONCLUSIONS

The pandemic appears to have particularly hindered urology resident geographic diversity at smaller programs. Although the initial effects have decreased since 2021, they have not returned to prepandemic status, and academic urologists must remain aware of the limitations and familiarity bias associated with the pandemic-era match process, which may hinder the diversity and fit of future resident classes.

These findings should be considered as programs and governing societies design upcoming cycles with hybrid application processes which ideally balance the cost-saving benefits of virtual programming with the geographic diversity and networking benefits of in-person events. Urology appears not to have suffered from geographic diversity issues as strongly as other surgical subspecialties, but much can be learned from this experience. Further study can better inform decision-making to ensure a successful match while safeguarding well-being during current and future public health crises.

CONFLICTS OF INTEREST

The authors (Nicholas J. Lanzotti and Jeffrey L. Ellis) declare no conflicts of interest pertaining to this publication.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at <https://doi.org/10.1016/j.urology.2023.01.050>.

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EDITORIAL COMMENT



This article provides a unique contribution to the literature in the form of a review of geography-based outcomes of the urology application cycle in the pre- and post-COVID period. Specifically, this analysis assessed the match patterns of applicants regarding their home institution and AUA section to assess if the COVID-induced residency application changes (i.e., virtual interviews, no away rotations, etc.) influenced where students ultimately matched. Their data was further stratified by small (≤ 2 residents/year) vs large (≥ 3 residents/year). The authors found that compared to prepandemic classes, small programs in the 2021 cycle took significantly more applicants from their home institution and from within their home AUA section. This trend held up when combining the 2021 and 2022 cycles however, it did not reach statistical significance when looking at the 2022 cycle alone compared to prepandemic classes. The authors did not find any significant differences when comparing the 2021 to the 2022 classes in these parameters. The authors postulate that smaller programs were more likely to match home students as they represented a “known entity” whereas large programs may have felt more comfortable with taking a student with whom they did not have firsthand experience given their relatively larger size.

As the authors pointed out, similar retrospective analyses of the impact of COVID-related virtual changes in recruitment on geographical distribution of applicants have been completed in urology as well as other specialties. A group from Boston University recently looked at this effect in the general surgery match and found that transitioning to virtual interviews did not significantly alter the applicants' geographical distribution.¹ While their analysis included data regarding distance traveled and average prices of flights, they did not include a breakdown by residency program size. It would be compelling to see if the transient “small program effect” noted in the urology match data by the authors holds true across other surgical disciplines or if this is a peculiarity limited to a specific time and field. Further, while the sub-analysis for single-resident programs did not carry statistical significance, we would caution against dismissing these results. As the authors admit, not all of these have affiliated home medical schools and there is still a large portion of their residents being taken from within their home AUA sections. While understanding these geographical trends is critical for stakeholders in recruitment, it remains just

one component of the field's collective effort to create a more equitable match process for applicants.

The landscape of urology residency recruitment has undoubtedly changed over the last 3 years in multiple arenas. Given the benefits of the virtual format pointed out by the authors (cost savings, carbon emissions) and published satisfaction with the format from both programs and applicants, it is safe to conclude the virtual format will remain a mainstay of urology residency recruitment.

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AUTHOR REPLY



We thank Dr. Lanzotti and Dr. Ellis for their comments and insight. They note that several studies have already looked at the impact of COVID-19 and virtual interviews on the geographical distribution of matched applicants in urology as well as in other specialties; however, ours is the first to consider the size of the residency program during the pandemic. As mentioned, it would be interesting to combine our “small program effect” with the variables studied in previous studies into one analysis. This includes both applicant factors, such as board scores, hometown, and subinternship locations (even if virtual), as well as program factors, such as prestige and location in a city vs a suburb. Some further studies to consider would be to include other small surgical specialties in which away rotations and letters of recommendation hold weight, like urology, in the interview offers and ultimate match. We agree with the commenters that it would be compelling to see if this “small program effect” is isolated to urology during the initial pandemic years, or if other specialties and times also see these trends. As discussed in our study, 2022 also marked the introduction of preference signaling into the urology match cycle, which could account for part of the return in geographic diversity that was compromised especially in smaller programs during the first pandemic match cycle. Signaling allowed applicants to formally express interest in a program or geographic location even if there were no previous geographic ties, and applicants were more likely to receive an interview from a program they signaled.¹ This would require surveys of applicants and a substantial response rate to build the variable into the statistical model.

The patterns of single-resident programs do still intrigue us. Although, the effects of the pandemic were not seen in these programs, it was a small sample size of single-resident programs with an associated medical school that was studied. Many single-

resident programs did not have an associated medical school, and as Kim et al.² recently found, the presence of a home urology residency program was the largest factor in the percentage of graduates entering urology, which leads us to think that the pandemic would have still caused these programs' applicants to match in affiliated or close-by institutions during the pandemic.

As efforts to increase diversity in all aspects continue, we do keep in mind that geographic diversity is different than other aspects of diversity, racial, economic, gender, etc. in that it has a component of preference and choice. It is likely that applicant preference for familiarity of a hospital system and being near a support system, and not only programs' choices for "known entity" play a role in smaller programs matching more students at home. We agree with the commenters that the virtual interview format is here to stay in some form, and that it brings equity to the application process by removing the costs associated with traveling to and staying at interview locations farther away or outside their medical school's AUA section.

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